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(54) Method for passivating aluminum-based metallizations.

(57) Aluminium-based alloy films and metallization layers that are patterned by reactive ion etching (RIE) are passivated by etching surface portions of the films or layers with a phosphoric-chromic mixture to remove contaminants and then oxidizing the exposed surface portions in an oxygen atmosphere.

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METHOD FOR PASSIVATING ALUMINUM-BASED METALLIZATIONS

The invention relates to a method for passivating a reactive ion etched (RIE) aluminum-based metallization patterned layer by oxidizing the exposed surface of said layer in an oxygen atmosphere.

The patterning of aluminum-based metallizations e.g., Al4% Cu by RIE is a process that can be used to manufacture microcircuit devices. Although RIE offers many advantages for microcircuit fabrication, it can promote atmospheric corrosion of the resultant Al or Al alloy conductor lines by introducing impurities (carbon and chlorine) and mechanical damage into the surface regions of the films. Consequently, the $Al_2 O_3$ surface layer that forms upon exposure of the metal to room air is substantially inferior in its passivating ability. The problem has been partially solved by sequentially rinsing the etched metallization and oxidizing in 1 atmosphere O_2 at approximately 350° Centigrade, as disclosed in Patent 4,183,781.

U.S. Patent 4,183,781, issued to J. M. Eldridge et al, discloses a stabilization process for aluminum microcircuits that have been formed by RIE. The patent cites U.S. patents 4,026,742 and 4,057,460 as exemplary illustrations of manufacturing process of this type. The patents do not address the problem of corrosion experienced with the Reactive Ion Etching of aluminum-alloys.

It is the object of the invention to minimize the corrosion experienced by the films in room air, following the patterning process.

This object is achieved by a method as defined at the beginning of this specification having the feature of the characterizing part of claim 1.

Advantageous embodiments of the invention are disclosed in the subclaims.

The invention will become more apparent from the following detailed description taken in conjunction with the accompanying drawing.

The drawing depicts a series of curves showing the relative amounts of Al corrosion versus the time of exposure in an accelerated atmospheric corrosion test chamber for two different prior art processes used to passivate reactively ion etched lines, and for the novel process of this invention.

In an implementation of this invention, a microcircuit is produced by an RIE process to delineate specified circuit patterns in an Al - 4% Cu film, by way of example. The invention works with other alloys of Al as well. The film of aluminum-copper alloy, which may contain 4% copper, by way of example, is deposited in vacuum on a passivated silicon semicondoctor device substrate. The alloy film is patterned by RIE and then immediately rinsed in deionized water upon removal from the vaccuum system.

In accordance with this invention, the following, novel processing steps are introduced to improve the corrosion resistance of the metallization layer. The first step is to strip the top air-formed oxide layer, which includes the bulk of impurities as well as a relatively small amount of the alloy below that. The oxidestripping is carries out

in a phosporic-chromic acid etchant for approximately 2 minutes at about 55° to 80°C. A preferred etchant mixture is 50 grams Cr 0_3, and 90 milliliters H_3PO_4 in 2500 milliliters of water total. The film is then rinsed in deionized water for about 5 to 10 minutes at room temperature, and blown dry in filtered air or nitrogen. The metal is then oxidized in one atmosphere of pure oxygen for about 30 to 45 minutes at a temperature in the range of 300 to 350°C. This sequence of process steps may be repeated to further enhance corrosion resistance.

With reference to the drawing, the curve designated as (a) represents the prior art processing of the aluminum-copper material by reactive ion etching, with a water rinse. The amount of corrosion is substantial after a few hours of exposure in an accelerated atmospheric corrosion test chamber.

Curve (b) represents the prior art processing in which oxidation at 350°C for 30 minutes in one atmosphere of oxygen follows the reactive ion etching, with water rinse. The amount of corrosion has been reduced substantially and occurs after several days of exposure in the test chamber.

Curve (c) depicts the corrosion effect occuring in the test chamber after employing the additional process steps of stripping in the phosphoric-chromic mixture and oxidizing in pure oxygen, in accordance with this invention. The improvement in passivation is much greater than that achieved with the process represented by curve (b).

C L A I M S

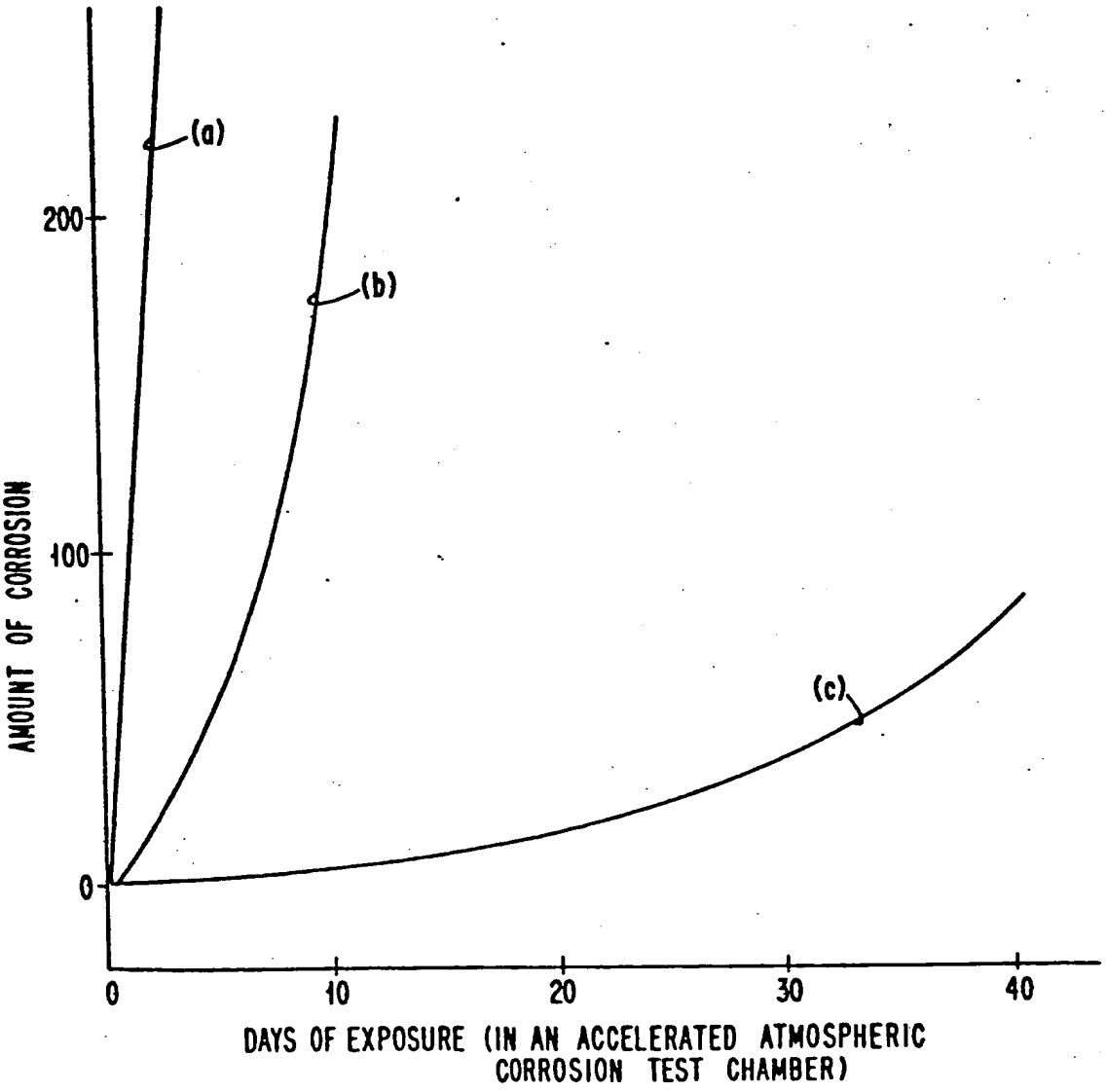
1. Method for passivating a reactive ion etched (RIE) aluminum based metallization patterned layer by oxidizing the exposed surface of said layer in an oxygen atmosphere, characterized in that etching surface portions of said metallization layer so that substantially all contaminants from the top air-formed oxide portion of said layer are removed.

2. Method according to claim 1, wherein said etching step is accomplished with an etchant of phosphoric-chromic mixture.

3. Method according to claim 2, wherein said mixture is formed with 50 grams CrO_3, and 90 milliliters H_3PO_4 in 2500 milliliters of H_2O total.

4. Method according to any one of claims 1 to 3, wherein said etching step is accomplished for approximately two minutes at about 55° to 80°C.

5. Method according to any one of claims 1 to 4, wherein said oxidizing step is accomplished in an atmosphere of pure oxygen for about 30-45 minutes at a temperature of about 300-350°C.


(a)
(b)
(c)
200
100
0
AMOUNT OF CORROSION
0
10
20
30
40
DAYS OF EXPOSURE (IN AN ACCELERATED ATMOSPHERIC CORROSION TEST CHAMBER)

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Application number

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EUROPEAN SEARCH REPORT

EP 82105213.1

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim
Y	DE - B - 1 205 192 (THE PLESSEY COMPANY LIMITED) + Column 3, lines 13-17; claims + --	1,2,4
Y	US - A - 3 666 642 (A.S. ALWAN et al.) + Fig. 2; claims + ----	1,5

CLASSIFICATION OF THE APPLICATION (Int. Cl. ³)

C 23 F 9/00
C 23 F 1/00
C 23 F 17/00
C 23 C 15/00

TECHNICAL FIELDS SEARCHED (Int.Cl.³)

C 23 F
C 23 C

CATEGORY OF CITED DOCUMENTS

X: particularly relevant if taken alone
Y: particularly relevant if combined with another document of the same category
A: technological background
O: non-written disclosure
P: intermediate document
T: theory or principle underlying the invention
E: earlier patent document, but published on, or after the filing date
D: document cited in the application
L: document cited for other reasons

&: member of the same patent family, corresponding document

X The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
VIENNA	06-08-1982	SLAMA